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REMARKS ON THE REPORT OF THE NATIONAL  
COMMITTEE ON MATHEMATICAL REQUIRE-  
MENTS ON COLLEGE ENTRANCE REQUIRE-  
MENTS.

I. BY E. R. HEDRICK, University of Missouri.

The report of the National Committee on College Entrance Requirements will seem at first to violate some of the traditions that we have held dear. It is my purpose to discuss briefly these changes and to try to evaluate the effects on collegiate mathematics.

Formerly, the teachers of mathematics in colleges thought of entrance examinations wholly from the standpoint of preparation for their own courses, and it was assumed that the work in mathematics in secondary schools would be shaped to prepare students for those courses. It is probably fair to say that this assumption is no longer the basis for college entrance examinations. It is generally recognized that the work of a high school should be determined by the best interests of those who constitute the majority in those schools, and it seems highly probable that college mathematicians can benefit mathematical instruction in the country far more by taking this attitude.

Wherever this view is accepted, an effort will certainly be made to revise the college courses in mathematics so that they will be adapted to the needs of students entering from secondary schools after those students have had courses based on the suggestions of the National Committee itself, or on other good authority.

While this should be the case in the courses in the Department of Mathematics, it is clear that courses in the other scientific departments can not be changed so readily. I understand that it is for this reason that the committee attempted to find out what topics in elementary mathematics were used most frequently by these other scientific departments. It seems to me that collegiate courses in mathematics could be changed in

the manner indicated above, and I believe that the change will be beneficial and stimulating, rather than otherwise. It is true the collegiate courses have become formalized no less than secondary courses, and that they stand in need of the reorganization which will be forced if this program is carried out.

It appears that the committee formulated this report without consciously considering its own previous report on Mathematical Requirements in Secondary Schools. This should have been done, perhaps, because it would be fair to assume that candidates for college entrance could make special preparation in the last years of the high school, if the requirements of college entrance differed materially from courses required in the high school for all students.

Perhaps the most surprising feature of the entire report is that it does agree in practically every essential point with the recommendations made in the report on Mathematical Requirements in Secondary Schools. I have just pointed out that this was not done by intention. Is it possible that this surprising result should have come about by accident and that that accident should have happened uniformly in the same sense with respect to a number of different topics? I believe that I can point out that the result is not at all accidental.

In the previous report for Secondary Schools, the committee announced as one of its fundamental principles that the topics selected should be based, not upon the requirements of courses that are to follow in later years, but rather upon the development of a better appreciation of civilization and a better understanding of life about us. The Report on College Entrance is not based on this principle, but on the needs of modern science in all the great departments of human knowledge. Is it simply by accident, then, that a topic discarded because it showed no immediate gain in the mastery of life, turns out to be of little or no consequence for later courses in the fundamental sciences? Or that a topic, included because it would add to the student's grasp of civilization, should turn out to be of considerable consequence in higher courses in science? It seems to me that the surprising agreement between these two Reports in spite of their different points of departure, is by no means accidental. If we honestly adhere to the basis of choice emphasized by the committee in its Secondary School

Report, we shall certainly secure topics that have direct connections with life and with world-activities. It is certainly to be presumed that higher courses in fundamental sciences will themselves deal with topics that affect real life and the activities of the outer world. If they do, it is not to be wondered at that students, trained toward greater control of life-activities, will also find themselves best equipped to carry on these higher courses. It has proved true in the past that a choice of topics based upon alleged needs of future courses has led, frequently, to a choice of meaningless manipulation, and of processes of no value, either at the time or at any future time. Hence I should prefer to take my chance with topics of known immediate value toward the appreciation of life and of civilization, and I would hope that these would prove to be most useful in collegiate courses, if those collegiate courses are themselves in tune with life.

II. BY H. D. GAYLORD, Brown and Nichols School,  
Cambridge, Mass.

The reports of the National Committee on Mathematical Requirements have given evidence of so much careful investigation and analysis that no teacher of the subject should fail to make a study of each forthcoming report. The committee gives us a preliminary report on College Entrance Requirements, which, although it is intended primarily for the guidance of those whose students expect to enter college, contains so much of value for all who teach either algebra or geometry that it is well worth careful consideration by all high-school teachers of mathematics.

This report makes a most helpful analysis of the relative values of the various topics in algebra and clears up much of the vagueness which the teacher is apt to feel in regard to the importance of certain parts of the course. It also points out the fact that the relative values set on these topics by the teachers of the social sciences and the teachers of the physical sciences in colleges are in striking accord with the other reports of the committee on programs in mathematics for junior and senior high-school students who do not intend to enter college.

This testimony from so many other fields that certain topics

in secondary school mathematics are essential to the proper appreciation of the material in those fields should give teachers of mathematics a better understanding of the remarkable part which mathematics plays in the whole structure of learning. If the teachers of mathematics can sufficiently detach themselves from the routine drill which is necessary for efficient preparation for the tests set by formal examination boards to view the subject of mathematics in a broad way, they will find in the first three topics of the minor requirement in elementary algebra much material which can be made useful in bringing the student into touch with the human side of mathematics.

Many of us have looked upon the formulas borrowed from the sciences and the engineering textbooks as either too difficult for the pupils to understand or as containing very little algebraic meat. Hence we have plunged ahead into the formal parts of the subject in order to enable the student to acquire quickly the ability to perform the six or eight stunts which are usually found on examination. The simple formula, the table of changing values, and the graph derived from such formulas or tables give an opportunity to link mathematics with the real life of the world and at the same time teach some of the great underlying mathematical facts. These topics which offer plentiful opportunity for practice in numerical computation should furnish an easy means of transition from arithmetic to algebra and a sufficient review of the fundamentals of arithmetic. They should offer also good illustrations of the need for the more generalized methods of algebra to replace the individual and particular applications of arithmetical numbers.

Although the report makes no attempt to prescribe a teaching order of topics, the suggestiveness of placing formulas, variables, and graphs at the beginning of the course before any attempt is made to introduce such formal algebraic conceptions as negative numbers and the methods of manipulation which are needed to make the four fundamental operations perfectly general should induce serious thought on the part of teachers. It suggests that, although students of high-school age are not philosophers and are not over-anxious to find reasonableness and logic in the development of the course, yet the need for a more general form of symbolism such as that used in algebra

should be shown to them through a series of problems which are closely enough connected with the real affairs of life to avoid giving them the feeling that algebra is an artificial system devised mainly for amusement or torture. The fact that algebra is generalized arithmetic makes its most compelling appeal to the student when he realizes that there is a real need for such a generalized arithmetic.

That part of the report which deals with the content of entrance examinations is especially valuable to the teacher of algebra because it offers so many suggestions in regard to the underlying objects of the course. It is very desirable that any course should have, in the mind of the teacher, a clearly defined purpose as a part of the whole educational plan of the school. The recommendations of this committee and of the committee appointed by the College Entrance Examination Board bring clearly before us the question of the results which we should expect to accomplish in the minds of the students who take the course in algebra. The entrance examination should be a test of the accomplishment of this result, and it is therefore highly desirable that the teacher should have constantly before him the real purpose of the course and continually test himself and his class in regard to their progress toward this end.

These recommendations suggest that "fully one third" of the questions should be of such a fundamental nature that all faithful students can be expected to answer them satisfactorily. If in connection with this recommendation the National Committee had set forth in a paragraph or two what constitutes that fundamental part of the course or had given a definite statement of the fundamental purpose of the course in algebra with a brief mention of the topics which bring out this purpose, this part of the report would have been even more helpful to teachers.

This broad purpose is suggested when the committee recommends that "The examination as a whole should, as far as practicable, reflect the principle that algebraic technique is a means to an end, and not an end in itself." We are left somewhat in the dark, however, as to what that end is. It is true that such a paragraph occurs on pages 2 and 3 of the report entitled *The Reorganization of the First Courses in Secondary*

**Mathematics.** This statement of the fundamental aims in the teaching of algebra cannot be too often repeated, and it would add much to the usefulness of this report if a place could be found for such a declaration of aims in connection with this warning to avoid excessive practice in algebraic technique and manipulation.

The report on First Courses says, "On the side of Algebra, the ability to understand its language and to use it intelligently, the ability to analyze a problem, to formulate it mathematically, and to interpret the result must be dominant aims. Drill in manipulation should be limited to those processes and to the degree of complexity required for a thorough understanding of principles and of probable applications either in common life or in subsequent mathematics." This statement of aims should be so clearly a part of every teacher's working plan that no undue amount of time would be spent on any topic in the hope of extending the student's knowledge to a point beyond which it will be useful in accomplishing these "dominant aims." Then the entrance examination may well test the accomplishments of the student on this basis by means of "simple and difficult questions testing the candidate's ability to apply the principles of the subject."